







Presented At
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Next Generation Technology Programs

- Next Generation Gas Turbine Systems (DE-AC26-00NT40851)
- Gas Turbine Reheat Using Insitu Combustion (DE-FC26-00NT40913)
- On-Line Thermal Barrier Coating Monitor for Real-Time Failure Protection and Life Maximization

 (DE ECOC OLNEALOSS)

(DE-FC26-01NT41232)



NEXT GENERATION GAS TURBINE SYSTEMS (DE-AC26-00NT40851)

Siemens Westinghouse Power Corporation for

U.S. Department of Energy National Energy Technology Laboratory



DOE's NGTP Goals and Suggestions

Compared to 1999 State-of-the-art systems, the proposed system shall be greater than 30 MWs and include:

- Improved LHV net system efficiency ≥15%
- ≥50% improvement in turndown ratio
- -≥15% reduction in COE, O&M and capital costs
- Improved service life
- Reduction of emissions (Carbon and NOx)
- Building Block for Vision 21 System
- Capability to use multiple fuels
- 400 starts / year with rapid start capability
- Improved RAM

DOE's suggested approach

 Solutions that embody development of several enabling technologies to enhance multiple concepts, cycle configurations, or fleet of existing core engines

DOE's suggested systems

- NGCC
- IGCC/PFBC/HIPPS
- Repowering
- Novel cycles
- Biomass / Alternate fuels
- Dual use technologies

DOE's suggested duty cycles

- Base load
- Distributed generation
- Flexible / intermediate duty
- Peaking
- Load following



Scope of Work

- > 22 Month Study
- Feasibility Study
 - System Definition
 - Market Assessment & Customer Surveys
 - Public/Vision 21Benefits
 - Development Plan
 - Technology Roadmap

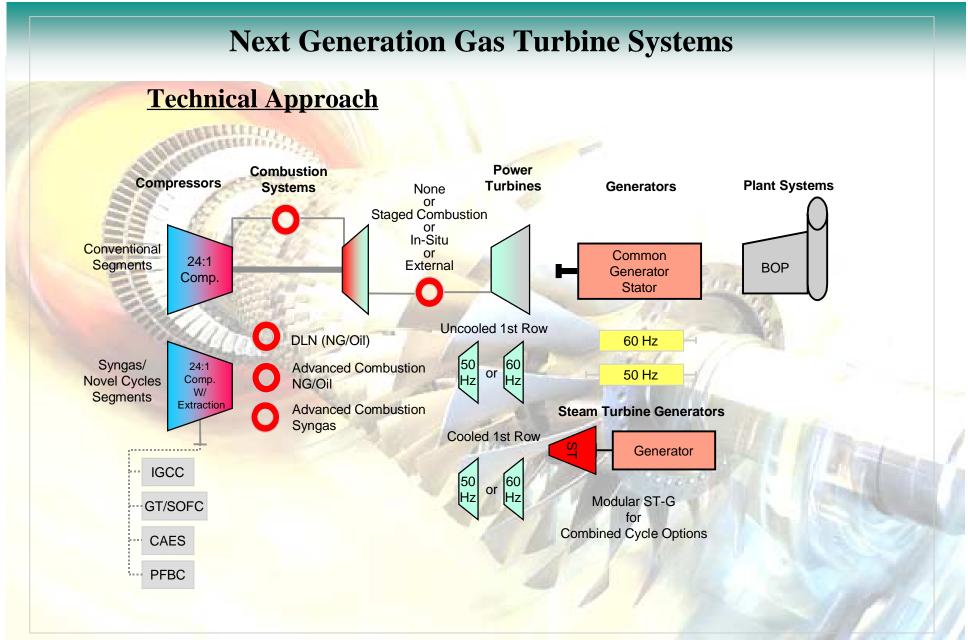
Objective

- ➤ Evaluate proposed modular NGGT system
 - Technical Feasibility
 - Economic Feasibility
 - Future Markets and Benefits
 - Development



Next Generation Gas Turbine Systems Program Strategy Service Market Upgrade Market Component Technology Spinoffs **Standard Base Design with** Conventional **Technology Modules to Address** Repowering **Base Load Specific Market Segments** Market Market Segment Segment Better Efficiency **Better Efficiency** Multiple Fuel Capability Multiple Fuel Capability START WITH **Higher Turndown Patio** 75 - 200 MW System Better Efficiency Multiple Fuel Lower Emissions (NO_x / CO₂) Syngas Capability Lower COE / O&M / Capital Cost Syngas / High H2 Market **Better RAM / Service Life** Integration Flexibility Segment Higher Exhaust Energy Better Efficiency Multiple Fuel Capability Rapid Start Higher Turndown · 400 Starts / Year Ratio Co-Gen Market **Intermediate Duty** Segment Market **Peaking Duty** Segment Market Segment







Study Major Results

GT Class	Performance	Costs	
130 MW Two Shaft	>15% eff. SC	vs. F-Class: Cost Increase.	
130 MW Single Shaft	>15% eff. SC	vs. F-Class: Same Cost	
270 MW Peaker (Note 1)	>14% eff. SC	vs. F-Class: >15% Cost Reduction	
		vs. G-Class: >20% Cost Reduction	
300 MW (NG)	>15% power SC	vs. G-Class: Cost Increase	
	>15% power CC	vs. G-Class: Cost Increase	
350 MW (syngas)	>15% power SC	vs. G-Class: Cost Increase	
	>14% power CC	vs. G-Class: Cost Increase	

Note 1. Optimization for SC efficiency results in decreased power, increased costs, and makes GT less compatible with the bottoming cycle.



Conclusions

- Technology Focus not Specific System Size
 - Development Costs
 - Uncertain Market
 - Better Investment: Efficiency, Power, Reliability
- Performance and Cost Goals Achieved for Specific Applications
- Larger GTs with Greater Reliability Preferred



GAS TURBINE REHEAT USING INSITU COMBUSTION (DE-FC26-OONT40913)

Siemens Westinghouse Power Corporation for

U.S. Department of Energy National Energy Technology Laboratory



Gas Turbine Reheat Using Insitu Combustion

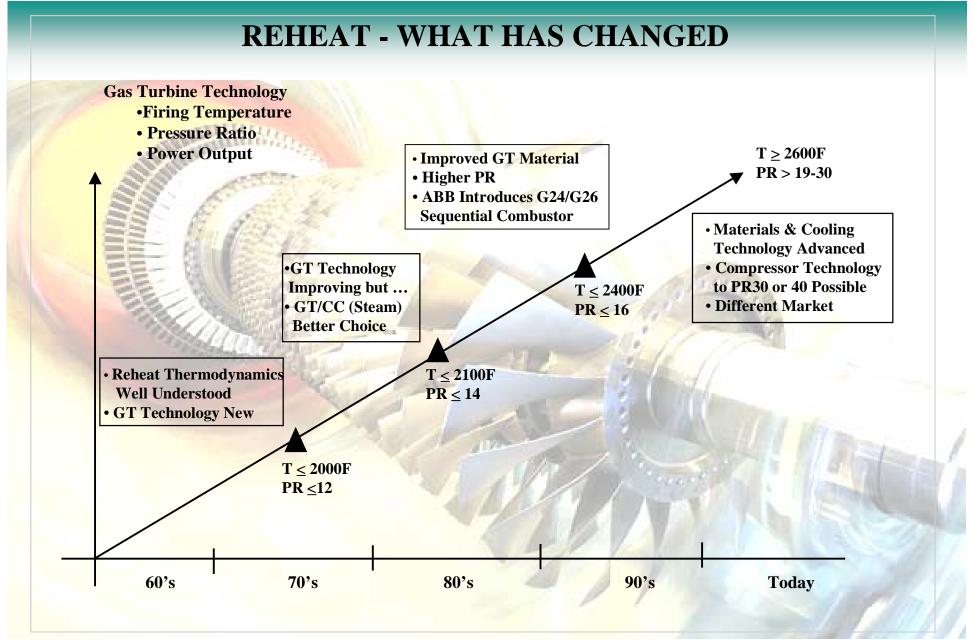
Scope of Work

- ≥ 2 yr. Program
- Establish Proof-of-Principal
 - Blade Path Aerodynamics
 - Combustion & Emissions
 - Subscale Testing
 - Conceptual Design

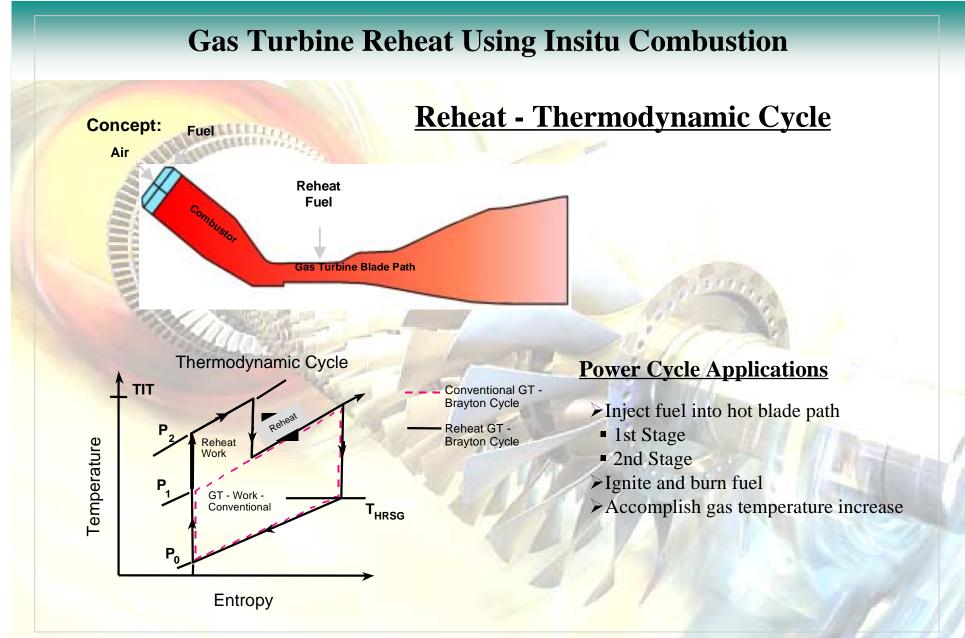
Objective

- Evaluate Insitu Combustion Process as a Means for
 - Cycle Reheat
 - Power Augmentation
 - Minimizing Blade Cooling Losses
 - Low NO_x Approach











Gas Turbine Reheat Using Insitu Combustion

Benefits

Applications	Market	
	Retrofit	New Engines
♦ "Reheat" for Efficiency and Power Gain		X
◆ "Reheat" for Power Augmentation	X	X
◆ "Reheat" as Approach for Minimizing Blade Cooling Losses	X	X
♦ "Reheat" as Low NO _x Approach	X	X

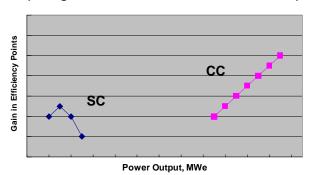


Gas Turbine Reheat Using Insitu Combustion

Technical Approach

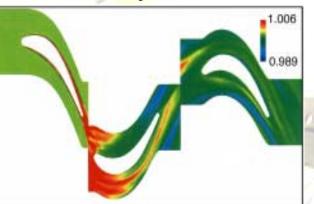
Cycle Analysis

Effect of First Stage Fuel Injection in 501FD (4-Stages, PR=16 and Turbine Exhaust< 1160F)



- 1. Define Engine/Cycle Advantages
 - Simple Cycle (SC)
 - Combined Cycle (CC)

Blade Path Aerodynamics



- 2. Develop Analytical and Modeling Tools
 - Quasi 3D
 - Limited Combustion Kinetics

Subscale Testing

3. Proof-of-Concept Testing





ON-LINE TBC MONITORING FOR REAL TIME FAILURE PROTECTION AND LIFE MAXIMIZATION (DE-FC26-01NT41232)

Siemens Westinghouse Power Corporation for

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Scope of Work

- > 4 Year Program
- System Definition and Design
- > IR Characterization and Development
- Sensor Development
- > TBC Life Model
- Supervisory System Development
- Field Testing

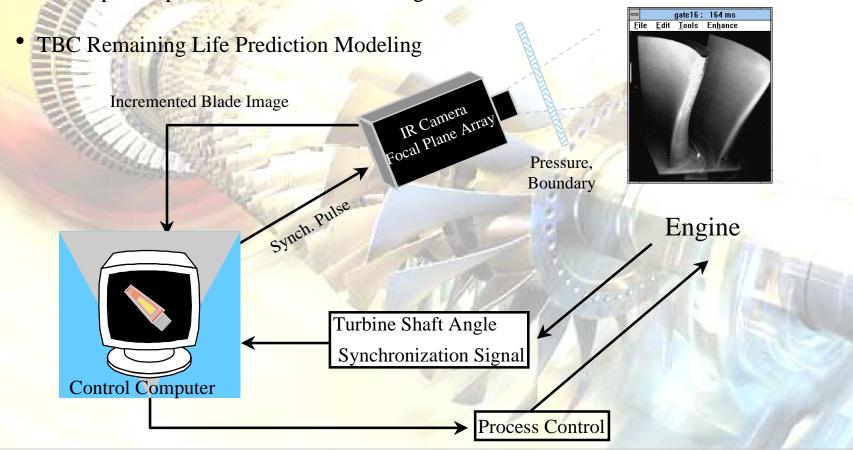
Objective

- Design and Test TBC Monitoring System for GT Blades and Vanes
- ➤ Monitor in Real-Time
- ➤ Analyze Radiance Map for Formation and Progression of TBC Defects
- Develop Lifing Model



Technical Approach

• Develop & implement advance monitoring sensors for row 1 vanes





• Define Processes with 3D Models

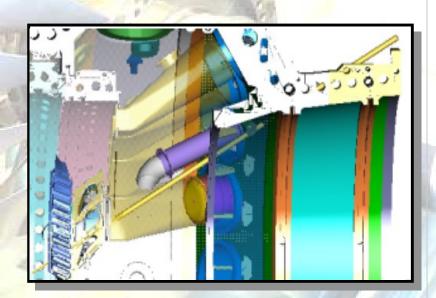


Technical Approach



Next Generation infrared sensors

• Define a radiance map of row 1 blades





Benefits

- Significantly improve plant reliability and availability by extending life of critical components
- Maximize safe operating life of critical components
- Reduce the risk of unscheduled outages
- Applicable to most styles of Gas Turbines
- Encourages US high tech jobs and employment